FLIGHT OPERATIONS SEGMENT

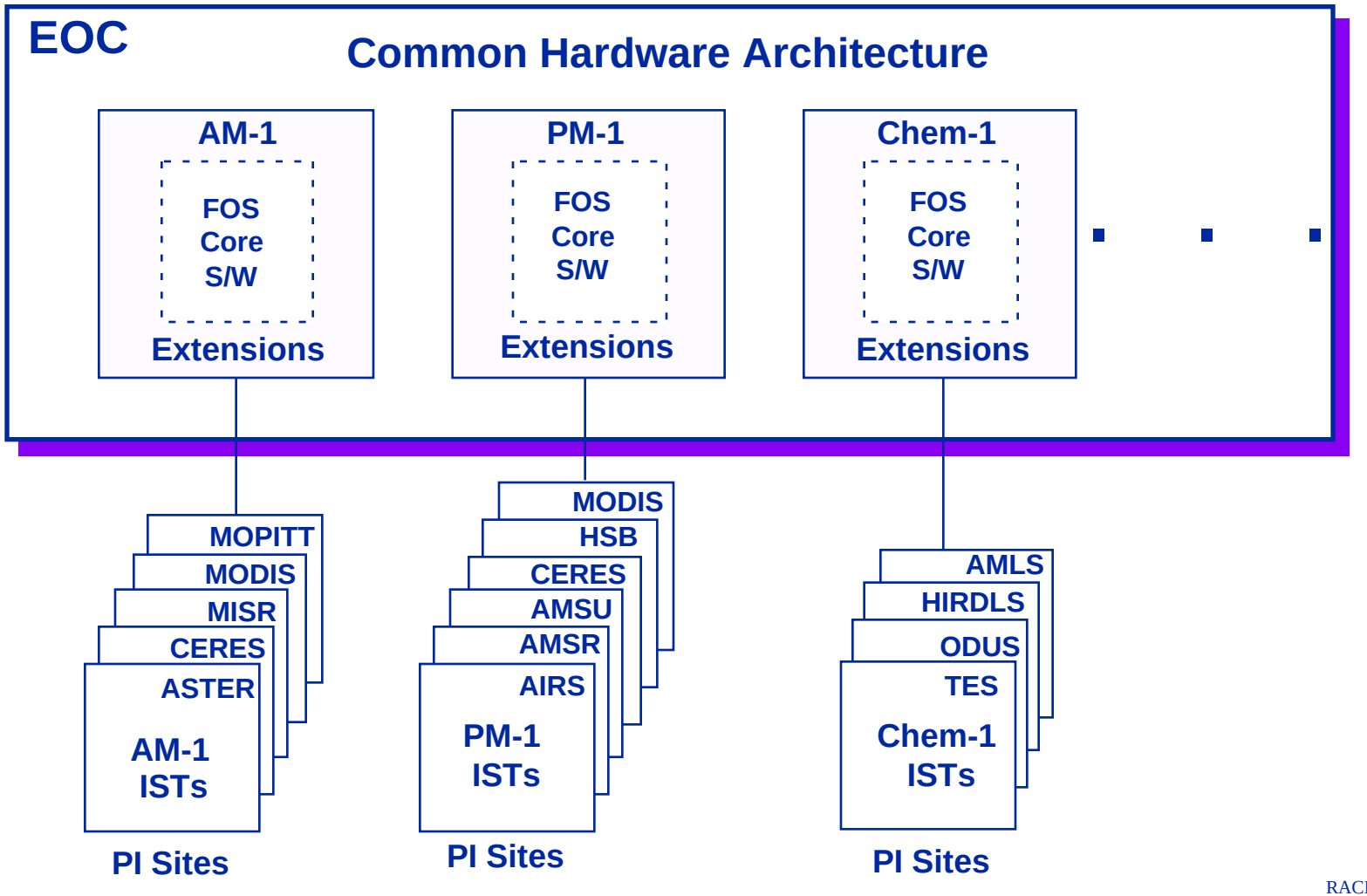
Mike Rackley
ESDIS Mission Systems Office

Goddard Space Flight Center/Code 510
Greenbelt, MD 20771 USA
E-mail: mike.rackley@gsfc.nasa.gov

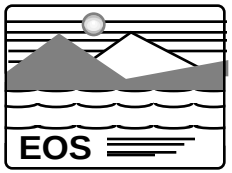
FOS System Overview

- FOS consists of the EOC and the IST
- EOC is the central operations focal point for AM-1 spacecraft and instrument planning & scheduling, commanding and health & safety monitoring/analysis
  - Physically located at GSFC Bldg 32
  - Multiple EOS mission operations facility (e.g., AM-1, PM-1, Chem-1)
- IST is a software toolkit that provides remote instrument operations teams with the ability to directly participate in instrument operations
  - Connected to EOC via the NASA Science Internet (NSI) (except ASTER ICC)
  - Planning and scheduling, with global visibility across Instrument Operations Teams (IOTs)
  - Offline analysis
  - Real-time monitoring during contacts

FOS Conceptual Architecture



FOS System Architecture

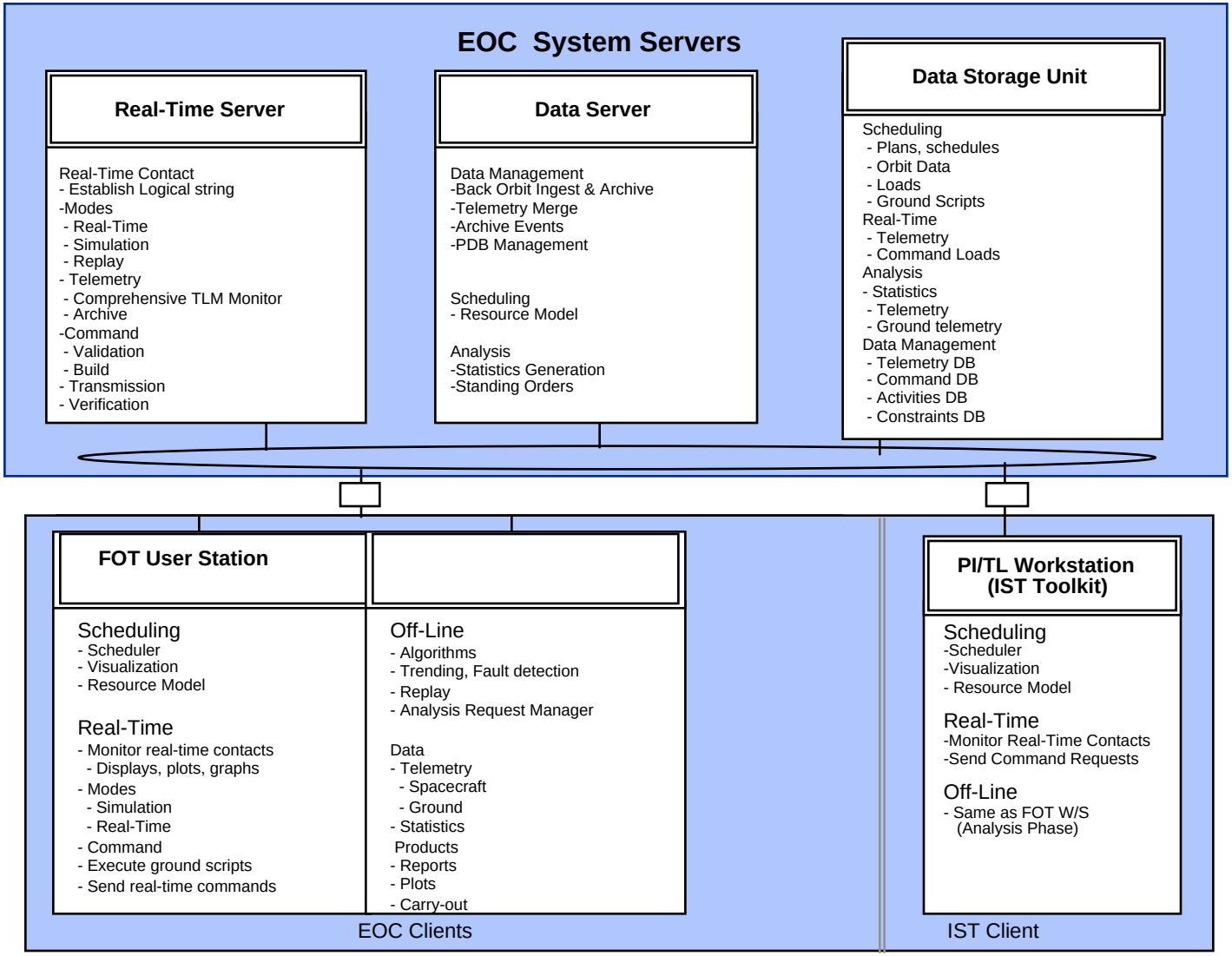


- FOS based on a distributed architecture that is scalable to adapt to full mission controlor a PI-oriented operations facility
  - Mid-level Unix workstations
  - RT and Data Servers and FOT User Stations
- RT telemetry processed by RT Servers and FOT User Stations
  - Packets multicast by EDOS to all EOC systems
- Command processing handled by RT Servers
  - Single point of command in entire facility
  - IOTs can request FOT to send RT commands via command requests from ISTs

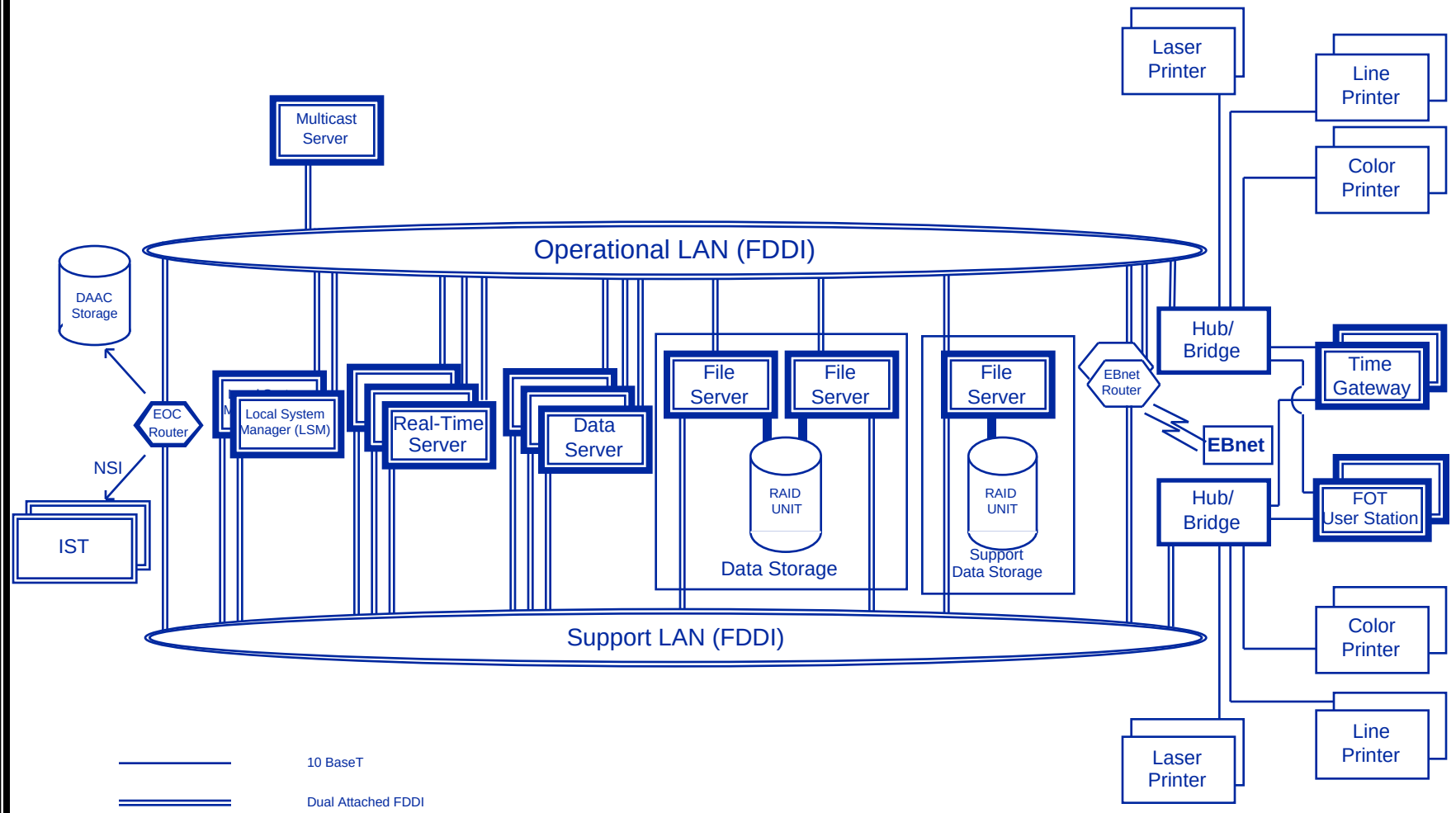
FOS System Architecture (Cont'd)

- Back-orbit (recorded) housekeeping telemetry data received and processed by Data Servers
  - EDOS sends as rate buffered data (RBD) files
  - EDOS automatically initiates file transfer within 5 minutes of receiving data at GSFC
  - Processed automatically by Data Servers upon receipt
    - » Data placed into history archive
    - » Statistics report generated
- All EOC workstations connected via operational and support (test) local area networks (LANs)
  - Fiber distributed data interface (FDDI) backbone and Ethernet

FOS System Architecture (Cont'd)



FOS Hardware Architecture



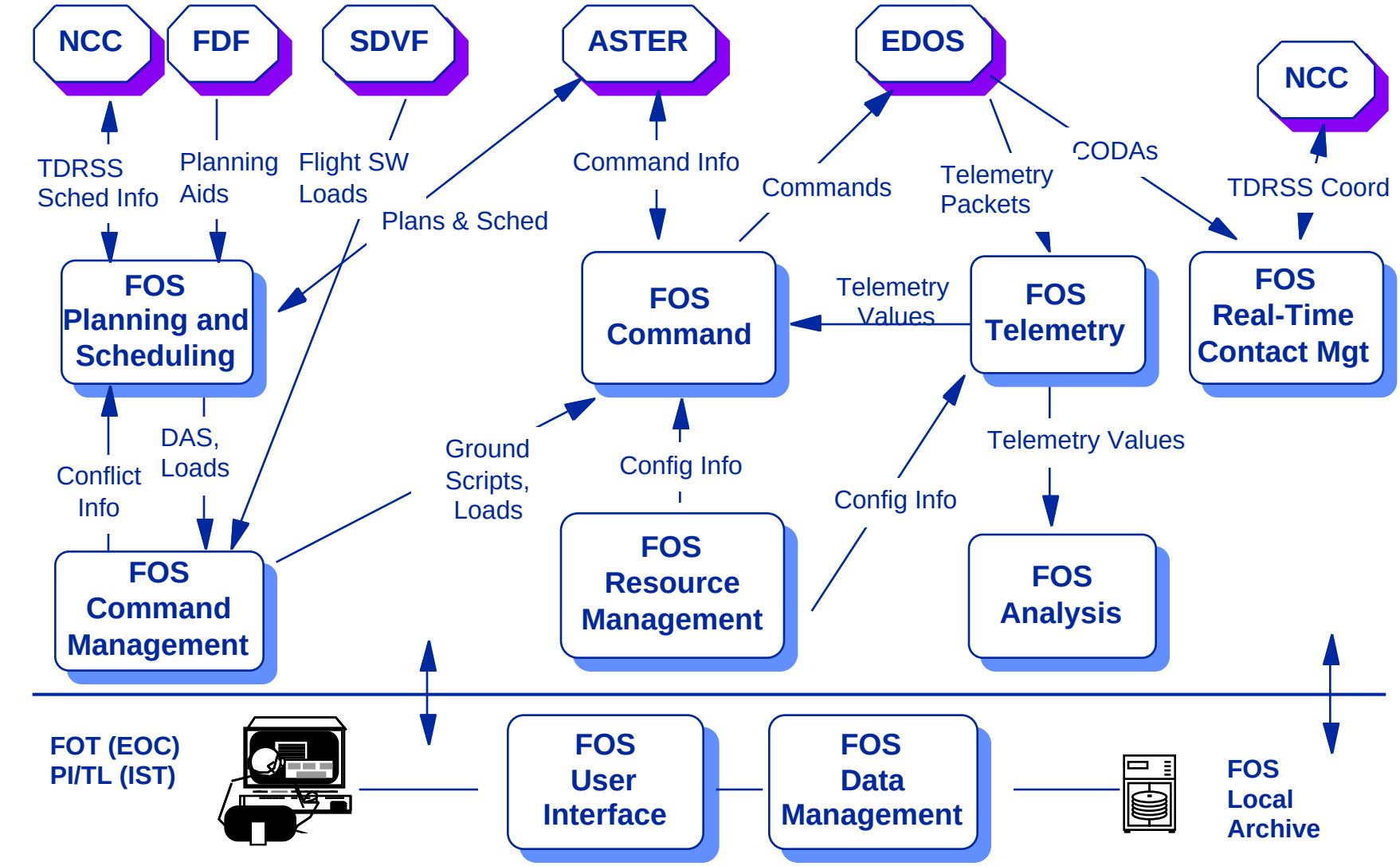
FOS Software Architecture

- Software architecture consists of functional subsystems all supported by common user interface and data management subsystems (infrastructure)
  - Common look-and-feel across subsystems
  - Seamless architecture
  - Object-oriented software design
  - Use of commercial off-the-shelf (COTS) wherever advantageous (e.g., Sybase, RTWorks, and Altair)
- Users participate in RT contacts (and offline replays) by joining logical strings
  - Hardware independent
  - Mirrored users slave to RT Server configuration
  - Tailored users can make localized configuration changes (e.g., limit or cal curve changes) on FOT User Station

FOS Software Architecture (Cont'd)

- Offline analysis automated via standing orders requests
  - All telemetry data available online (locally in EOC or remotely from GSFC DAAC)
  - Statistics reports/trend plots
  - Also available to ISTs, with request running either in the EOC or at the IST (user choice)
- Planning and scheduling performed by FOT and IOT personnel using FOT User Stations and distributed ISTs
  - Mission timeline of spacecraft and instrument activities
  - Global visibility for all users
  - Operations automated via Baseline Activity Profiles (BAPs)
    - » Typically based on orbital events
    - » Example: Perform activity "Calibration X" at each equator crossing
  - End products = ground script for conducting contacts and command/table loads for uplink

FOS Software Architecture (Cont'd)



FOS External Interfaces

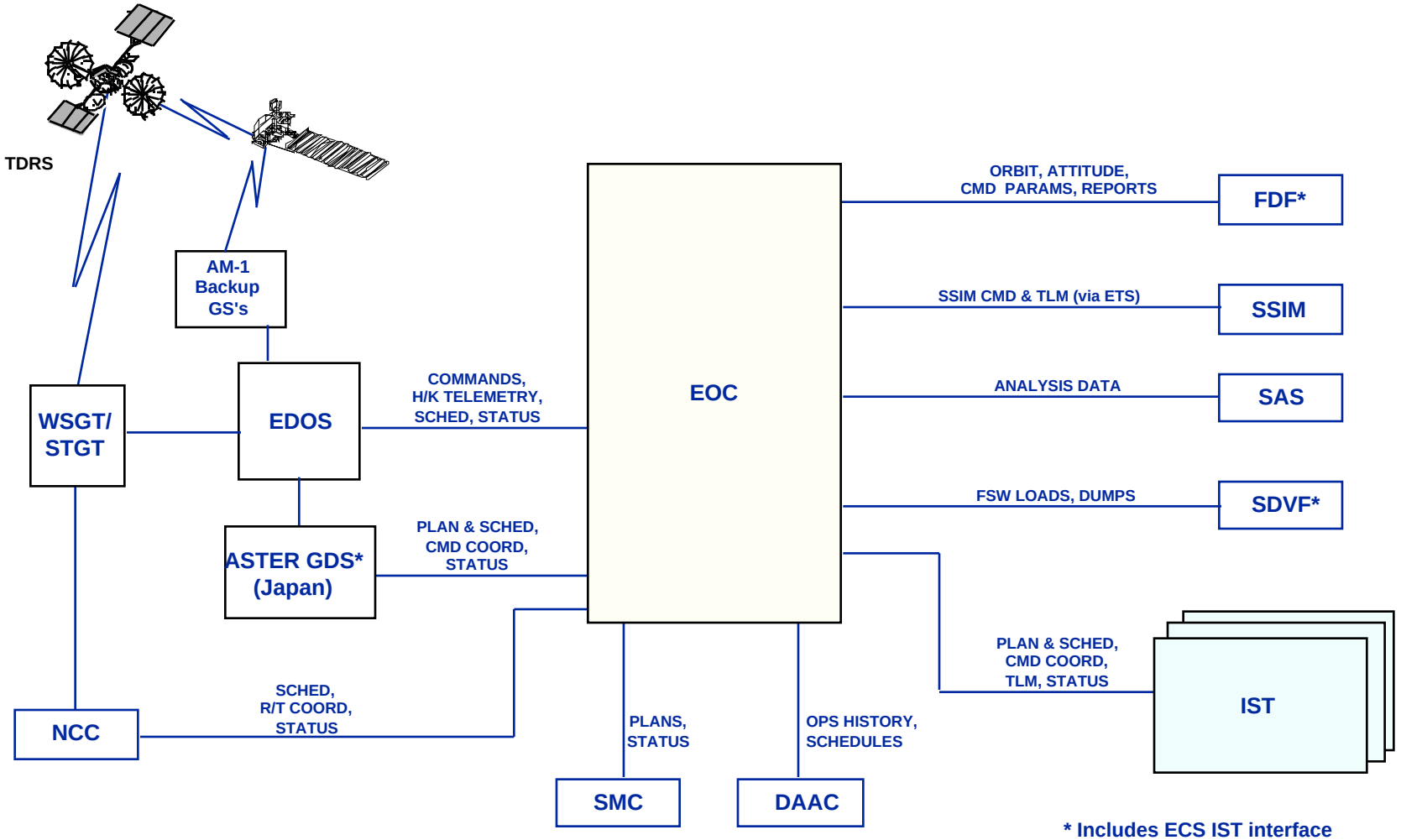
- **EDOS**
  - **Provides telemetry and command interface to spacecraft**
- **ASTER GDS**
  - **Provides primary ASTER instrument operations support**
- **NCC**
  - **Provides SN scheduling and TDRS monitoring**
- **FDF**
  - **Provides orbit and attitude support**
- **SAS**
  - **Provides spacecraft-unique performance analysis to augment FOS-provided capabilities**

FOS External Interfaces (Cont'd)

- **SSIM**
  - **Provides spacecraft simulation for flight team training and certification**
- **GSFC DAAC**
  - **Provides long term on-line operations history data archival (e.g., telemetry data and event logs)**
- **SDVF**
  - **Provides flight software maintenance, initially by spacecraft contractor, then by GSFC/Code 512**
- **SMC**
  - **Provides overall EGS performance trending**

All ICDs baselined except FDF, which is under CCB review

FOS External Interfaces (Cont'd)



FOS Development Plan

- System delivered in two releases
- Release A provides support infrastructure and basic functionality
  - Basic RT telemetry and command processing
  - External interface connectivity
  - Initial set of P&S, analysis, and user interface tools
  - Command and table load generation
- Release B provides full functionality needed for AM-1 launch

FOS Development Plan (Cont'd)

- After Release B delivery, system goes under sustaining engineering support
  - Actual software maintenance generally supported by same development team members (i.e., no handoff to separate team or contractor)
  - Primarily focused on three areas
    - » Discrepancy fixing
    - » Operations enhancements (mostly per FOT/IOT requests)
    - » Modifications needed to respond to new or changed AM-1 spacecraft information/requirements
- Combined development/operations and government/ contractor team will prioritize and plan sustaining engineering activities

FOS Release A Capabilities

Scheduling

Planning & Scheduling
BAP Definer Tool
Activity Definer Tool
Detailed Activity Schedule
Timeline Tool
ASTER I/F Filter

Command Mgt
Uplink Load Generation
ATC Load Generation
Ground Sched Generation
Load Manager
Microprocessor Loads
RTS Load Builder
Table Load Verification

Real-Time

Resource Mgt
String Manager
Command Authority
Ground Control Privilege

Telemetry
Decom Engine
Mirrored Telemetry
Parameter Server

Command
Cmd Validation, Generation, Uplink, and Notification

Real-Time Contact Mgt
NCC GCMRs

Analysis

FUI
Analysis Request Tool
Analysis Report Generation

Analysis
User Selected Statistics
Basic Analysis Request
Expert Advisor

Data Mgt
Data Archive
Retrieve Events

Support Services

ECL	Screen Management	Display Builder	Time Selector	DB Generation
Events	Window Manipulation	Procedure Builder	Ground Script Control	(Activities, Cmd, Tlm)
Help	Status Window	Room Builder	DB Edit	

Infrastructure

Message Passing	Name Services	Network Services	Interface Connectivity
Security Services	Directory Services	Management Services	Time Services

FOS Release B Capabilities

Scheduling

Planning & Scheduling
Timeline Tool
Planning Aids Mgt
TDRS Scheduling
Activity Constraint Check
What-If
Schedule BAPs

Command Mgt
Cmd Constraint Check
Load Catalog and Reports
RTS Load Manager
Generate Patch Loads
Memory Mgt/Compares

Real-Time

Resource Mgt
String Cfg Change Requests
Resource Monitor
Failure Recovery

Telemetry
Derived Parameters, Selective Decom, Tailored Telemetry
S/C State Check
Memory Dump

Command
Cmd Verification
Load Processing

Real-Time Contact Mgt
NCC ODMs, EDOS CODAs

Analysis

FUI
Standing Orders

Analysis
Clock Correlation
Solid State Recorder Mgt
S/C Activity Log
System Statistics
User-Defined Algorithms

Data Mgt
Triggers
Queue Mgr

Support Services

User Customization
E-Mail
Document Reader
Report Browser/Editor Tool
Quick Msg & Analysis
Display Builder (schematics)
DB Backup/Restore
Quick Analysis
Event History Tool
DB Reporting
Info Window
Data Mover

Infrastructure

Release A Capabilities
Additional Management and Communication Services

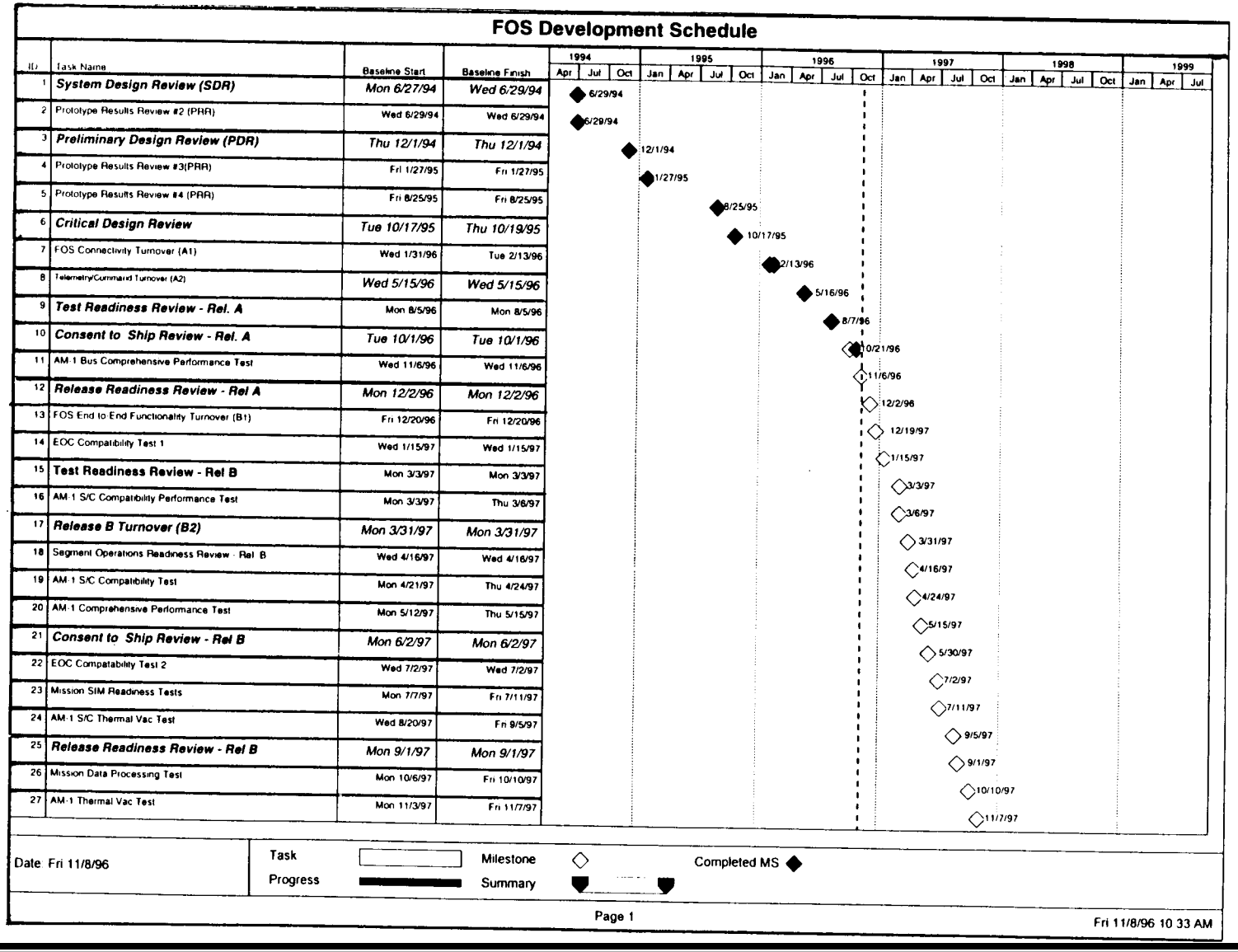
FOS Status/Schedule

- Release A currently in acceptance testing
  - Conducted by development contractor
  - All hardware installed in EOC
  - Scheduled for completion early December 1996
    - » System then delivered to ESDIS for EGS testing
  - Spacecraft test support: ECT-1 January 1997
  - ISTs distributed to instrument teams February 1997
- Developer utilizing streamlined, combined testing approach
  - Combined two test teams into one FOS Test Team
  - Consolidated separate test procedures into one set
  - Testing period simply divided into two phases
    - » Dry-Run testing
    - » Acceptance testing (formal repeat of Dry-Run tests)

FOS Status/Schedule (Cont'd)

- Release B under development (code/unit test)
  - Testing scheduled to begin March 1997
  - Delivery to ESDIS September 1997
  - Spacecraft test support
    - » ECT-2 July 1997 with test version
    - » ECT-3 January 1998
  - IST's distributed October 1997
- Main EOC facility work/installations completed (AC rehab, carpet, power and furniture)
  - Currently housing EBnet and EDOS V2 hardware
  - Will also house FDF workstations, SAS, EOSDIS Test System (ETS), SSIM, and Instrument Ground Support Equipment (IGSE)

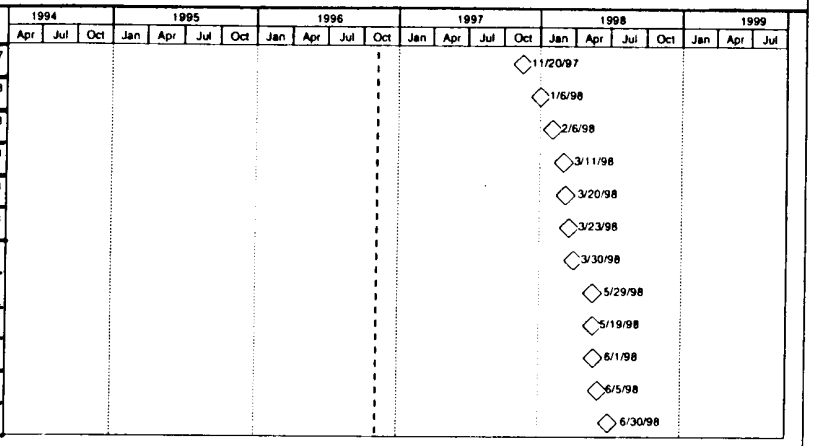
FOS Development Schedule



FOS Development Schedule (Cont'd)

FOS Development Schedule

ID	Task Name	Baseline Start	Baseline Finish
28	AM 1 S/C Post Acoustics Compatibility Performance Test	Mon 11/17/97	Thu 11/20/97
29	FOC Compatability Test 3	Fri 1/2/98	Tue 1/6/98
30	AM 1 Comprehensive Performance (Post Acoustics) Test	Mon 2/2/98	Fri 2/6/98
31	AM 1 End to End Test	Tue 3/3/98	Wed 3/11/98
32	Mission OPS Simulation	Mon 3/9/98	Fri 3/20/98
33	Mission Ops Simulation	Wed 3/18/98	Mon 3/23/98
34	Operations Readiness Review	Mon 3/30/98	Mon 3/30/98
35	Ground Data System Test	Mon 5/18/98	Fri 5/29/98
36	AM 1 Flight Readiness Review	Tue 5/19/98	Tue 5/19/98
37	AM 1 Comprehensive Performance (Launch Site) Test	Thu 5/21/98	Mon 6/1/98
38	AM 1 Launch Site Readiness Test	Tue 6/2/98	Fri 6/5/98
39	***AM-1 Launch***	*Tue 6/30/98*	*Tue 6/30/98*



Date Fri 11/8/96

Task
Progress
Milestone
Summary
Completed MS

Page 2

Fri 11/8/96 10 33 AM

EOC Facility Layout

RELEASE "B"
6/21/96

EOC FACILITY

BLDG 32